-- SLATERSVILLE RESERVOIR UPPER DAM --

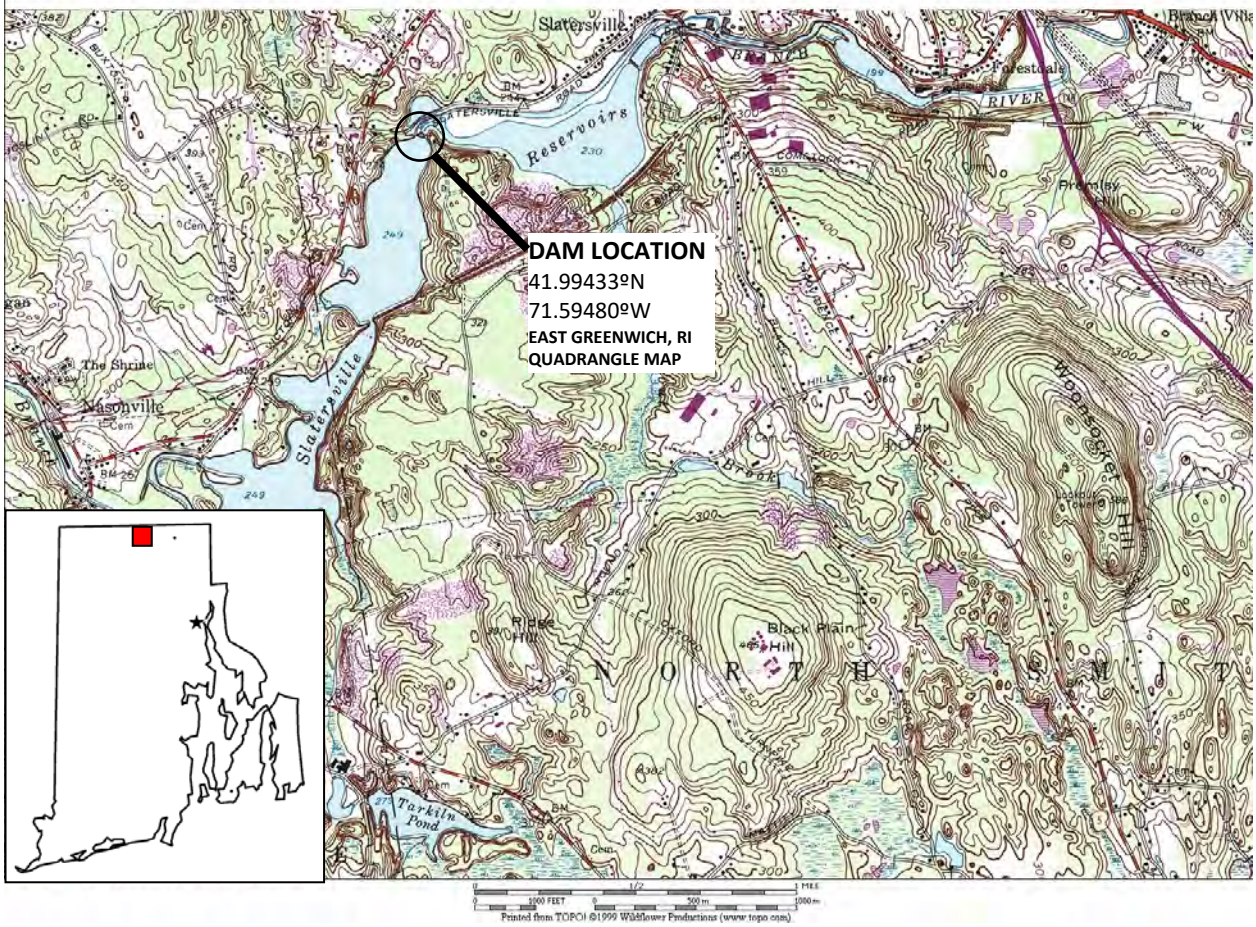
VISUAL
INSPECTION / EVALUATION REPORT

Dam Name:	***Slatersville Reservoir Upper Dam***
State Dam ID#:	***043***
Owner:	***Dudley Development Corp.***
Town:	***North Smithfield***
Consultant:	***Pare Corporation***
Date of Inspection:	***May 23, 2019 (Revised 9-5-19)***

PARE CORPORATION

INSPECTION SUMMARY

Dam Name (No):	Slatersville Reservoir Upper Dam (#043)
Location:	North Smithfield
Hazard Classification:	High
Inspector:	David R. Caouette, P.E., Pare Corporation
Inspection Date:	May 23, 2019



When describing the dam, "left" and "right" refer to the respective sides of the dam as viewed when facing downstream (with normal flow of water).

PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the dam was based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

J.Matthew Bellisle, P.E.
PARE CORPORATION
Senior Vice President

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1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The RIDEM Office of Compliance and Inspection has retained Pare Corporation of Foxboro, Massachusetts and Lincoln, Rhode Island to perform a visual inspection and develop a report of conditions for the Slatersville Reservoir Upper Dam along the Branch River in North Smithfield, Rhode Island. This inspection and report were performed in accordance with current Rhode Island laws.

RIDEM will develop an overall condition rating based upon the data presented herein. It is understood that this rating will consider operational and structural deficiencies and will be presented under a separate cover.

1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with current dam safety regulations to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into three parts: 1) obtain and review reports, investigations, and data pertaining to the dam and appurtenant structures available within the Rhode Island Department of Environmental Management files; 2) perform a visual inspection of the site; and; 3) prepare and submit a final report presenting the evaluation of the structure, including recommendations for additional studies, repairs, and remedial actions.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided at the end of this report. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) hazard classification; 4) general; and 5) condition rating.

1.2 Description of Project

1.2.1 Location

The Slatersville Reservoir Upper Dam is located approximately 35 yards east of the residential structure at 368 Main Street in the Town of North Smithfield. The dam, located along the northeast edge of the reservoir at coordinates 41.99433°/71.59480°, is privately owned, and abuts a gravel path that connects to Main Street. Please refer to the inspection summary for a locus plan depicting the area of the dam and its immediate surroundings.

To reach to the dam from Route 295 in Rhode Island, take exit 18B and travel on Route 146 north for about 5.2 miles, then take the ramp right for Pound Hill Road. At the end of the ramp turn right onto Pound Hill Road. After 0.3 miles bear right onto Industrial Drive and travel for 1.1 miles. At the end of Industrial Drive turn right onto Providence Pike (Route 5) and travel for 0.4 miles and continue onto Main Street and travel 0.9 miles to 368 Main Street. The dam can be accessed via a dirt path located west of the residence at 238 Main Street.

1.2.2 Owner/Caretaker

The dam is owned by the Dudley Development Corp., which also has responsibility for the operations and maintenance of the structure. No contact information for the Owner was available.

1.2.3 Purpose of the Dam

The dam was constructed about 1886 as part of a mill complex. The original use of the dam and reservoir has been abandoned and the dam no longer serves its original intent.

1.2.4 Description of the Dam and Appurtenances

As stated in the 1887 Annual Report of the Commissioner of Dams and Reservoirs:

> This dam has been constructed during the year embraced in this report. It is composed entirely of stone laid in cement, practicably forming a monolith, the entire structure, both bulkhead and dam, resting upon, and abutting against, a ledge of solid rock.
>
> The rollway extends over the entire length of the dam, whose alignment of 170 feet, forms the arc of a circle whose radius is 237.82 feet, the chord 166.25 feet, and versed sine 15 feet.
>
> The structure is 35 feet wide at the base, and 28 feet high from foundation to crest of rollway, and the top of the dam at the abutments is 7 feet above the crest of rollway.
>
> The two draw-off gates at the bulkhead are each 3-1/2 by 6 feet opening dimensions.

As paraphrased from the 1979 USACE Phase I Inspection Report,

> The Slatersville Reservoir Upper Dam is approximately 256 feet long and consists of a 170-foot long, 12-foot high ashlar masonry arched overflow section, with left and right ashlar faced masonry abutments. On the dam proper, the downstream slope of the overflow section has a slight batter and the upstream face is made up of a gravel fill at a slope of about 2.5 horizontal to 1 vertical.
>
> Through the left abutment are located two sluiceways measuring 3.5 feet wide and 6.0 feet high, which are controlled by wooden slide gates. The two low level outlets are respectively located approximately 40 and 50 feet from the left abutment. The gates are not in an operating condition due to missing parts. At the foot of the left abutment is an old canal. This canal once extended from the upper reservoir to the mill site located below the lower dam. The canal was filled in for most of its length in recent years.
>
> About 85 feet downstream of the main dam is located a toe dam [Slatersville Upper Intermediate Dam] (RI045), which is approximately 6 feet high. To the north of this toe dam there is another toe dam [Slatersville Upper Trench Return No. 1] (RI044) along the outlet canal, which permits overflows from the canal to enter the main run of the river. An old plan

indicates the entire dam rests on bedrock. A capstone sill along the spillway crest serves as a control. The total length of the dam is about 256 feet.

The 28-foot high embankment at the left abutment is supported upstream by a stone masonry wall with an exposed face of approximately 6 to 28 feet ,with deeper sections of wall near the two low level outlet intakes. Above-water heights were measured at approximately 8 feet. The right abutment consists of a short granite block gravity embankment approximately 10-feet wide that is founded on exposed bedrock.

A letter dated February 2018 indicates that in November 2017 the Dam Owner "lined [the two sluiceways] with steel box inserts securely fastened and sealed to the interior sluiceway walls and fitted with bulkheads." Within each of the bulkheads was a butterfly valve (diameter not confirmed) with a hand crank operator wheel that can be operated to pass flow into the downstream channel. Based on a review of photographs included with the letter, it appears that in order to operate the outlet a diver must be in the water alongside the outlet/butterfly valve. It also appears that the butterfly valves are significantly smaller than the original sluiceway openings.

1.2.5 Operations and Maintenance

Operation and maintenance responsibilities have not been assigned to other than the current owners. There are no current operational or maintenance level activities undertaken at the dam. Since the previous inspection in 2009 the low-level outlet controls have been removed and the downstream discharge openings have been fitted with steel plates bolted to the downstream wall. It also appears that brush and trees have been removed from the left and right sides of the downstream canal downstream of the low level outlet.

1.2.6 Hazard Potential Classification

In accordance with current classification procedures under State of Rhode Island dam safety rules and regulations, RIDEM has classified the Slatersville Reservoir Upper Dam as a HIGH hazard potential dam.

1.2.7 Available Hydraulic and Hydrologic Data

The following paragraphs are paraphrased from the 1979 USACE Phase I Inspection Report:

Test Flood Analysis. Slatersville Reservoir Upper Dam is about 27 feet high and impounds about 3,640 acre-feet to top of dam. A test flood of a magnitude corresponding to ½ PMF was selected for the evaluation.

The NED March 1978 Preliminary Guidance Memorandum for Estimating Probable Discharges was used for estimating the maximum probable flood peak flow rate; the PMF was then divided by two to arrive at the test flood value. The test flood inflow for Slatersville Reservoir Upper Dam, having a drainage area of 88.0 square miles, was determined to be about 210 CSM, or about 18,500 cfs. Flood routings through the reservoir were performed for both the ½ and the full PMF in the analysis. Results of these routings are summarized as follows:

Flood Magnitude	Max. Routed Outflow cfs	Max. Res. El. ft. NGVD	Max. Head Over Dam ft.	Max. Disch. Over Dam cfs
½ PMF (Test Flood)	18,500	261.60	2.1	18,000
PMF	37,000	266.40	6.9	35,200

From the above table, it can be seen that the project will not pass the routed test flood outflow without overtopping the dam by 2.1 feet. The project, however, can handle 66% of the routed test flood outflow without overtopping the dam. The spillway capacity at the top of the dam is 11,925 cfs.

Dam Failure Analysis. As discussed above, the dam would be overtopped by the routed test flood outflow. Also, a breach of the dam owing to structural failure by piping is a possibility. For this analysis a breach was assumed with the water level at the top of dam. The "rule of thumb" criteria suggested in the NED March 1978 Guidance Report was used. With a breach width of 40% of the dam length, or about 68 feet, an outflow of about 23,200 cfs, which includes 7,155 cfs from the intact portion of the spillway would be realized.

In reaches below the dam, the outflow first passes through the Slatersville Middle Reservoir and then the Lower Reservoir. Beyond the reservoirs, the outflow passes under the Providence Turnpike (Route 5) through a masonry, twin-arch bridge. Beyond the bridge a mill is located high on the left bank and an industrial complex occupies the right bank at a lower elevation. The flow is then confined to a narrow ravine as it threads its way to another mill dam and pond. This lower dam is located about 2 miles below Slatersville Reservoir Upper Dam. Below this dam the river again is confined to a steep ravine until it reaches the vicinity of the Smithfield Expressway (Route 146) and the Louisquisset Pike (Route 146a). In this area the river valley widens but no structures exist in the valley. Beyond the Louisquisset Pike the river narrows and is confined until it reaches its confluence with the Blackstone River at a point about 3.67 miles below the Slatersville Reservoir Upper Dam.

It is estimated that flows over the Slatersville Middle Dam and Lower Dam will rise about 2 feet due to a breach in the Upper Dam. The most significant area to be impacted as a result of a breach of the dam would be the area extending immediately downstream of the Lower Dam for a distance of about one-half mile. The Providence Pike and a few industrial buildings located within this reach would sustain significant damage if a breach should occur. The only other structures that would sustain damage are three homes and a restaurant which are located about 8,600 feet downstream of the Slatersville Reservoir Upper Dam. At this location the river stage would increase in depth on the order of 2 feet to 5 feet.

2.0 INSPECTION

2.1 Visual Inspection

The Slatersville Reservoir Upper Dam was inspected on May 23, 2019. At the time of the inspection, temperatures were near 60°F with mostly cloudy skies. Photographs to document the current condition of the dam were taken during the inspection and are included at the end of this report. The level of the impoundment appeared to be at least 3 to 5-inches above the spillway crest. Flows over the crest and limited access to the crest prevented a direct measurement. Underwater areas were not inspected as part of the field activity.

For reference purposes, a baseline was established along the crest of the dam embankment. Station 0+00 was located at the right abutment and extended to Station 2+50 at the left abutment. Observations are reported in relation to their location along the baseline as noted herein.

2.1.1 General Findings

In general, Slatersville Reservoir Upper Dam was found to have inoperable low-level outlets, areas of missing mortar within stone masonry, grasses and weeds growing from stone masonry, stumps and woody brush growing along the downstream channel slopes, unknown source of seepage into the downstream canal, and additional dam safety concerns/deficiencies. The specific concerns and other observations made during the site visit are identified in more detail in the sections below:

2.1.2 Dam Embankment

Masonry Dam-Upstream Side

- Erosion up to 2-feet behind the upstream wall was observed at the left abutment contact.
  - Erosion extended for the full height of the upstream wall; approximately 4-feet
  - Chainlink fence posts in the area of the erosion were completely undermined and were partially toppling the fence.
  - Grass, woody brush, weeds, vines and leaf litter were observed on the ground adjacent to the wall.
- The stone and ashlar masonry walls appeared to have good horizontal and vertical alignment. Grass, ferns, vines and small woody vegetation (diameters less than ¼-inch) were observed growing within the stone masonry.
- Some loss of mortar was observed at the water line along the stone masonry sections of the upstream walls. No mortar loss was noted in the ashlar masonry sections.
- The ashlar masonry was not accessed right of the spillway, however the following was noted based on observations made from the left abutment:
  - The right abutment was constructed atop and into a bedrock outcrop
  - Alignment of the wall appeared normal.
  - Vegetation on the upstream face included tall weeds (up to 3 feet in length).

Masonry Dam-Crest

- Contact with the left abutment appeared normal with no signs of unusual movement. A hill contacts the left abutment.
    - Trees up to 12-inches diameter are located approximately 15-feet beyond the abutment contact.
    - The ground was covered with leaf litter, tall grasses, weeds, and woody brush.
    - A chain-link fence ran along the abutment/dam contact. The fence was intact.
- Between STA 0+00 and 0+30 the crest is a 2.5-foot wide section of upstream stone masonry wall.
    - Vertical and horizontal alignment appeared normal
    - There was a steel railing located along the top of the wall. The railing was missing the upper rail between STA 0+15 and the low-level outlet.
- The crest between STA 0+30 and 0+65 was covered with a concrete slab located between the upstream and downstream walls for the low-level outlet structure.
    - Surface cracking with grass growth was typical throughout the crest.
    - Areas of spalling up to ½-inch deep and 5 square feet were typical.
- The right abutment was not accessed during the visit; however, the following was noted based on observations made from the left abutment:
    - The surface between the upstream and downstream ashlar masonry walls was covered with short grass. Other surface treatments or concrete condition could not be assessed
    - Based on available aerial imagery and visual observation it appeared that trees and other woody brush were cleared within at least 25 feet of the abutment
    - The abutment contact appeared normal but could not be assessed for localized signs of cracking or unusual movement.

Masonry Dam-Downstream Side

- Left abutment contact appeared normal with no signs of cracking or unusual movement.
- Between STA 0+00 and STA 0+25 the downstream slope was a 2H:1V grass and weed covered slope. Many areas of the slope were bare, with exposed soils and roots. The slope transitioned to the downstream masonry wall at STA 0+25 and to a steep 1H:1V or steeper slope adjacent to the downstream channel at the low-level outlet.
- The ashlar masonry wall between STA 0+30 and the primary spillway is also integral to the low-level outlet structure
    - The masonry appeared to have good vertical and horizontal alignment with no signs of movement.
    - There were no signs of seepage from the downstream face of the wall.
    - There were areas of cracked mortar between stones.
    - Vegetation within the wall was limited to small tufts of grass, weeds, and ferns.
- The ashlar masonry was not accessed right of the spillway, however the following was noted based on observations made from the left abutment:
    - The right abutment was constructed atop and into a bedrock outcrop
    - Alignment of the wall appeared normal.
    - Vegetation on the downstream face included tall weeds (up to 3 feet in length) and short woody brush.

2.1.3 Appurtenant Structures

Primary Spillway

- The level of the impoundment appeared to be at least 3 to 5-inches above the spillway crest; limiting inspection of the upstream approach, crest, and downstream face of the spillway.
- Flow passing over the primary spillway generally appeared uniform indicating a uniform vertical alignment.
- The left and right training walls are ashlar masonry and appeared to have good stone contact and normal alignment.
- The approach was generally clear of debris.
    - A large tree trunk was stuck on the crest near the left side of the spillway. It appeared that higher flows would dislodge the trunk and pass it into the downstream area.
    - Other small stick debris was lodged on the crest throughout the spillway, but would not affect higher flows.
    - Several tree trunks and branches were stuck on the right side of the spillway in such a way that they spanned the gap between the spillway crests and downstream bedrock outcrop, effectively preventing flow over the rightmost 20 feet of the spillway. It appeared that extremely high flows would be required to dislodge this debris.
- The discharge area was generally clear of debris.
    - Bedrock outcrops are located at the toe of the spillway within 40-feet of the left side of the spillway and within 20-feet of the right side of the spillway.
    - Saplings, vines, and small woody brush were observed growing within rock joints of the rock outcrop on the left side of the spillway.
- The following was observed for the left face of the masonry wall forming the left downstream channel wall of the primary spillway (also forms the right channel wall for the low level outlet).
    - Wall alignment appeared normal with no signs of unusual movement.
    - Mortar was generally intact and stone contact and chinking stone coverage appeared normal with the exception of the section of wall within 2 feet of the bedrock interface (also the apparent high water mark).
        - Mortar was missing within much of this area.
        - Stones appeared to be placed out of alignment with the rest of the wall. While this appeared to be an as-built condition, flow over the bedrock interface and along the toe of the wall made this difficult to confirm.
    - Isolated tufts of grass and ferns were observed growing from the wall. In two locations saplings up to 1-inch diameter were observed growing from the wall.

Low Level Outlet

- The ashlar masonry forming the upstream face appeared to have good contact between stones and normal alignment. Isolated tufts of grass and ferns were observed growing from the wall.
- The low-level outlets were not operable.
    - There were no operators on the upstream side of the outlet structure.
    - There was no observable stem or other indication of a gate on the intake for the leftmost gate.
    - A timber gate stem was present extending from the intake of the rightmost gate. There was no rack attached to the exposed portion of the stem.

  - The downstream discharge point for both the left and right outlets were covered with a steel plate bulkheads and bolted to the stone masonry. Assuming a square opening the plate was bolted with approximately 36 bolts. There appeared to be a gasket or sealant applied between the steel plate and the stone masonry.
    - Gates and operators within the steel plate bulkheads were not visible and were underwater at the time of the inspection.
  - There were no signs of leakage or moving water from the outlets; however, this observation was made from the top of the dam as the channel could not be safely accessed.
- The following was observed for the right face of the masonry wall forming the right downstream channel wall of the low level outlet spillway (also forms the left channel wall for the primary spillway).
  - Wall alignment appeared normal with no signs of unusual movement.
  - Mortar was generally intact and stone contact and chinking stone coverage appeared normal the toe of the wall was obscured by vegetation and or the tailwater within the canal.
  - Isolated tufts of grass and ferns were observed growing from the wall.
  - Saplings up to 1-inch diameter, woody brush, vines, and weeds were observed growing from the lower portions of the wall, along the bedrock interface, and along the canal water line
  - The lower 5-feet of the wall was observed to be weeping; however, no areas of concentrated flow were observed.
- The left side of the low-level outlet canal is retained by a bedrock outcrop followed by a steep 1H:1V slope. The slope was covered with cut back woody vegetation, vines, weeds, and saplings. Several large stumps, up to 24-inches diameter, were present on the slope.
- While no areas of concentrated flow were observed the canal downstream of the low-level outlet was filled with generally clear water, indicating that it was not stagnant.
  - There was roadway drainage entering the canal further downstream. Based on grading and quantity of flow from the drainage culvert, it appeared at the time of the inspection that the canal would have to be fed by a source of water between the dam and the drainage culvert.
  - It appeared that the canal water was slightly lower than the Upper Dam tailwater; and approximately 2 feet higher than the Intermediate Dam tailwater.

2.1.4 Downstream Area

The area downstream of the dam is primarily a river area with a series of several dams. A toe dam (Slatersville Upper Intermediate Dam; RI#045) is located about 85 feet downstream of the Slatersville Reservoir Upper Dam. To the northeast of this toe dam there is another dam (Slatersville Upper Trench Return Dam; RI044). A bridge along Main Street crosses the bend of the river approximately 110 yards downstream of the dam. The area further downstream of the dam is a pond impounded by the Slatersville Reservoir Middle Dam (RI046) about 0.8 mile downstream. Further downstream is the Slatersville Reservoir Lower Dam (RI047) (0.9 mile downstream) and a bridge supporting traffic along the Providence Pike/Rt 5 (1.0 mile downstream). Residential structures line the northern shore of the downstream pond with the closest structure within 50 feet horizontal and 20 feet vertical from the water's edge.

2.1.5 Reservoir Area

The impoundment is surrounded by dense woodland. To the west residential properties abut the woodland while to the east is the Holliston Sand Quarry. Slopes surrounding the impoundment area moderate to steep with areas of tall bedrock outrcops. The slopes generally appeared stable with no evidence of erosion that could be indicative of loose soils or potential slides.

2.2 Caretaker Interview

No Owner contact information was available; therefore, the owner of the dam was not available during the field inspection.

2.3 Operation and Maintenance Procedures

There is no formal operations and maintenance manual known to exist for this dam.

2.3.1 Operational Procedures

There are no formal or informal operations known to be performed at the dam. With the closure/sealing of the low-level outlets there are no operable components at the dam.

2.3.2 Maintenance of Dam and Operating Facilities

There are no known formal or informal maintenance procedures performed at the dam or its operating facilities. Note that since the previous inspection the low-level outlet discharges have been sealed and the old operators have been removed. Based on available aerial photography the downstream slope for the canal appears to have been cleared sometime between June 2010 and April 2012.

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

The Slatersville Reservoir Upper Dam was found to have the following deficiencies:

1. Inoperable low-level outlets.
2. Erosion along the upstream slope at the left abutment contact
3. Areas of mortar loss, vegetative growth within stone joints, and seepage through the stone masonry wall separating the primary spillway channel and the low level outlet canal
4. Areas of brush, stumps, and other unwanted vegetation along the downstream toes of walls and along the spillway and canal channel slopes.

Based upon a comparison of conditions reported in the 2009 Visual Inspection/Evaluation Report, conditions at the dam appear to have improved. It appears that the low-level outlets, previously reported as leaking, have been sealed on the downstream side by a steel plate bolted to the downstream wall face. Based on available aerial imagery and conditions reported during the last inspection, the majority of large diameter trees were cleared from the canal side slope between June 2010 and April 2012. Erosion along the upstream slope at the left abutment has continued to develop. The following table provides a summary of previously noted deficiencies and their current condition.

Previously Identified Deficiency/Recommendation	***Resolution or Current Condition***
Erosion up to 18-inches along the upstream contact with the left abutment	Erosion has increased to at least 24-inches behind the wall and 4 feet deep.
Small trees growing from the training wall joints	It appears that most of the large vegetation has been cleared from the dam. Saplings less than 1-inch were seen growing from the walls in isolated locations.
Mortar loss and grass growth from wall joints	No apparent Change
Rehabilitate the Low-level Outlet	The outlet has been sealed on the downstream side
Clear the dam of unwanted vegetation	Based on Aerial imagery dam was cleared between 2010 and 2012 but vegetation is returning
Underwater inspection	No apparent change
Repair deteriorating masonry	No apparent change
Complete an H&H	No apparent change
Complete a formalized O&M Manual	No apparent change.

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs, or remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of RIDEM or other regulatory agencies.

3.2 Recommendations

The following paragraphs present additional studies, routine and recurrent operations and maintenance activities, and repairs recommended to address deficiencies noted during the inspection and the completion of this report. The recommendations provided below should be implemented in accordance with general dam safety practice. Further, if left unaddressed, many of the conditions

identified above will continue to deteriorate, could compromise the future safety of the dam and appurtenant structures, as well as become more costly to fix in the future.

1. Improve operability to the low-level outlets. Currently, the outlets are only operable from the downstream side and require a diver in the water adjacent to the outlet to open the valves. Evaluate the existing condition of the low-level outlets, including the completion of an underwater inspection. Depending on the results of the evaluation, either complete repairs as needed or install new outlet controls to maintain low-level drawdown capacity.

2. Continue to clear the entire crest of the dam of brush and other unwanted vegetation. Biannual clearing (i.e. late spring and fall) is recommended to keep the vegetation from returning. When brush is cut down, it should be removed from the dam to permit a clear view of the embankment. Significant root systems, including root systems and stumps from previous clearing activities, should also be pulled and the resulting holes properly filled. ***Care should be taken when grubbing adjacent to and within the wall sections so as not to damage or undermine the structures. All root systems within walls should be cut flush with the wall face.***

3. Subsequent to clearing, tree and stump removal, and regrading along the upstream side of the left abutment, provide slope protection at the abutment contact area to protect the embankment from erosion due to wave action and runoff. Slope protection would likely consist of stone riprap with properly designed bedding stone and geotextile fabric. During design of the slope protection system, the extents of riprap installation should be evaluated.

4. Perform masonry repairs along the crest and retaining walls at the dam structure, including, but not limited to, and concrete along the spillway training walls, upstream walls, and downstream walls.

5. Perform an underwater inspection of the upstream walls to assess the mortar within the joints, erosion along the base of the wall, missing stones, and movement. Repairs should be completed as needed.

6. Complete an underwater inspection of the spillway to assess mortar condition, alignment, erosion, and leakage. To complete this work, temporary cofferdams may be needed in order to divert flows from the downstream sections involving multiple stages of cofferdam installations. Repairs should be completed as needed.

7. Regular maintenance activities should be implemented to control and prevent growth of unwanted vegetation, including brush and trees from the embankment, abutments, and spillway areas.

8. A formalized Operations and Maintenance Manual should be developed for this structure. This manual should include procedures for maintaining the level of the impoundment, including adjusting the level of the impoundment in anticipation of rain events to provide additional free board during the wetter months. Additionally, the manual should include periodic inspection schedules and operational and maintenance procedures required to ensure satisfactory operation and minimize deterioration of the facility.

9. Implement a program of regular inspection and monitoring of the dam. Included in the monitoring program should be continued regular monitoring of areas of brush and vegetation,

and any other areas of suspected movement or concern. As the dam is a high hazard dam, the completion of a formal inspection by a RI registered professional engineer familiar with dam engineering is recommended every 2 years.

3.3 Alternatives

The following alternatives are presented based upon a conceptual review of the concerns. Additional studies and or considerations may indicate that some or all of the options presented below are not suitable for the conditions specific to this dam and dam site. In addition to the general activities, appropriate environmental permits will be required to complete many of the alternatives presented below.

Dam Removal/Breaching: Alternative to implementing any of the repairs noted above, breaching of the dam is a viable alternative for addressing safety and stability concerns at the dam. While this alternative will address the safety concerns at the dam, it will result in the loss of the recreational and environmental resource and reduce flood control capacity provided by the dam and impoundment. Additionally, while removal will result in elimination of yearly operating and maintenance expenses, permitting activities and construction costs associated with dam removal may exceed those of rehabilitation and operations and maintenance.

In evaluating the potential for dam removal several preliminary studies should be completed including:

- Hydrologic/Hydraulic Analysis similar to those described above should be completed to assess any changes that may occur during routine storm events.
- A review of the historic significance that the structure may have with the community, if any. This review should include discussions with the local and state historic commissions.
- A review of rare or endangered species which may be present in the area and dependent upon the resources created by the dam.
- An analysis of the volume, character and disposition of the sediment behind the dam. This is required to understand the amount of material to be removed or stabilize the potential for contamination within the sediment which would require special handling, and potential scouring which would result in the migration of sediment through the downstream reaches.

Once these preliminary studies and reviews have been completed the permit requirements should be reviewed.

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to State of Rhode Island Rules and Regulations for Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.
Downstream – Shall mean the high side of the dam, the side opposite the upstream side.
Right – Shall mean the area to the right when looking in the downstream direction.
Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – means any barrier made by humans, including appurtenant works, which impounds or diverts water.
Embankment – means the fill material, including but not limited to rock or earth, placed to provide a permanent barrier that impounds water.
Crest – Shall mean the top of the dam, usually provides a road or path across the dam.
Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.
Appurtenant Works – means any ancillary feature of a dam including such structures as dikes, training walls, spillways, either in the dam or separate there from, low level outlet works, and water conduits such as tunnels, channels, pipelines or penstocks, either through the dam or its abutments.
Spillway – means a structure, a low area in natural grade or any part of the dam which has been designed or relied upon to allow normal flow or major flood flow to pass over or through while being discharged from a reservoir.

Hazard Classification

High Hazard – means a dam where failure or misoperation will result in probable loss of human life.
Significant Hazard – means a dam where failure or misoperation results in no probable loss of human life but can cause major economic loss, disruption of lifeline facilities or impact other concerns detrimental to the public's health, safety or welfare. Examples of major economic loss include but are not limited to washout of a state or federal highway, washout of two or more municipal roads, loss of vehicular access to residences, (e.g. a dead end road whereby emergency personnel could no longer access residences beyond the washout area) or damage to a few structures.
Low Hazard – means a dam where failure or misoperation results in no probable loss of human life and low economic losses.

General

EAP – Emergency Action Plan – Shall mean a predetermined (and properly documented) plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam failure.
O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.
Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.
Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet.

Height of Dam– means the vertical distance from the elevation of the uppermost surface of a dam to the lowest point of natural ground, including any stream channel, along the downstream toe of the dam.
Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.
Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.
Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.
Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.
Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.

Condition Rating

Unsafe – Means the condition of a regulated dam, as determined by the Director, is such that an unreasonable risk of failure exists that will result in a probable loss of human life or major economic loss. Among the conditions that would result in this determination are: excessive vegetation that does not allow the Director to perform a complete visual inspection of a dam, excessive seepage or piping, significant erosion problems, inadequate spillway capacity, inadequate capacity and/or condition of control structure(s) or serious structural deficiencies, including movement of the structure or major cracking.*
Poor – A component that has deteriorated beyond a maintenance issue and requires repair.; the component no longer functions as it was originally intended.
Fair – Means a component that requires maintenance
Good – Meeting minimum guidelines where no irregularities are observed and the component appears to be maintained properly.

* Structural deficiencies include but are not limited to the following:

- Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
- Missing riprap with resulting erosion of slope
- Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
- Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
- Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
- Inoperable outlets (gates and valves that have not been operated for many years or are broken)

REFERENCES AND RESOURCES

The following reports were located during the file review completed at RIDEM Offices in Providence, Rhode Island and within Pare's archives:

1. "Letter RE: RI Dam No. 43", prepared by Michael P. DeFrancesco, P.E., Dated: February 16, 2018.
2. "Slatersville Reservoir Upper Dam, Visual Inspection/Evaluation Report", prepared by Pare Corportation, November 12, 2009
3. "Slatersville Reservoir Upper Dam, Dam Inspection Report", RIDEM Office of Compliance and Inspection, May 25, 1999.
4. "Slatersville Reservoir Upper Dam, Phase 1 Inspection Report, National Dam Inspection Program", USACE, September 1979.
5. "Slatersville Reservoir Upper Dam, Dam Inspection Report", RIDEM Office of Compliance and Inspection, April 10, 1978.
6. "Slatersville Reservoir Upper Dam, Dam Inspection Report", RIDEM Office of Compliance and Inspection, September 20, 1946.
7. "Design of Small Dams", United States Department of the Interior Bureau of Reclamation, 1987
8. "ER 110-2-106 - Recommended Guidelines for Safety Inspection of Dams", Department of the Army, September 26, 1979.
9. "Guidelines for Reporting the Performance of Dams" National Performance of Dams Program, August 1994.

The following were referenced during the completion of the visual inspection and preparation of this report and the development of the recommendations presented herein

10. "Design of Small Dams", United States Department of the Interior Bureau of Reclamation, 1987.
11. "ER 110-2-106 - Recommended Guidelines for Safety Inspection of Dams", Department of the Army, September 26, 1979.
12. "Guidelines for Reporting the Performance of Dams" National Performance of Dams Program, August 1994.

The following provides an abbreviated list of resources for dam owners to locate additional information pertaining to dam safety, regulations, maintenance, operations, and other information relevant to the ownership responsibilities associated with their dam.

1. RIDEM Office of Compliance and Inspection Website: http://www.dem.ri.gov/programs/benviron/compinsp/
2. "Dam Owner's Guide To Plant Impact On Earthen Dams" *FEMA L-263,September 2005.*
3. "Technical Manual for Dam Owners: Impacts of Plants on Earthen Dams" *FEMA 534, September 2005.*
4. "Dam Safety: An Owners Guidance Manual" *FEMA 145,December 1986.*
5. Association of Dam Safety Officials – Website: www.asdso.org/
6. "Dam Ownership – Responsibility and Liability", ASDSO.

VISUAL DAM INSPECTION
LIMITATIONS

Visual Inspection

1. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

2. In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team. In cases where an impoundment is lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

3. It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Use of Report

4. The applicability of environmental permits needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of any regulatory agency.

5. This report has been prepared for the exclusive use of the RIDEM for specific application to the Slatersville Reservoir Upper Dam in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

6. This report has been prepared for this project by Pare. This report is for preliminary evaluation purposes only and is not necessarily sufficient to support design of repairs or recommendations or to prepare an accurate bid.

Photo No. 1: Upstream left abutment contact. Note collapsed fence post due to erosion behind the wall.

Photo No. 2: Upstream wall between the left abutment and primary spillway. Arrows indicate the low-level outlet gate stem (right) and former operator locations (left & right).

Photo No. 3: Downstream slope between the left abutment and STA 0+30.

Photo No. 4 : Right abutment as viewed from the left side of the primary spillway.

Photo No. 5: Downstream wall between STA 0+30 and the primary spillway.

Photo No. 6: Overview of the primary splllway.

Photo No. 7: left downstream face of the primary spillway and left downstream channel wall. Note the tree trunk lodged on the crest, the bedrock outcrop in the immediate downstream area, and the vegetation growing from the downstream channel wall..

Photo No. 8: Downstream face of the primary spillway.

Photo No. 9: Right abutment contact and downstream face of the primary spillway. Note debris spanning the spillway crest and downstream bedrock outcrop. Staining on the bedrock outcrop indicates that high flows have passed over the debris without removal.

Photo No. 10: Plugged downstream outlets of the low-level outlet

Photo No. 11: Downstream right channel wall for the low-level outlet/left channel wall for the primary spillway. The arrow indicate the location of observed trace seepage from the wall.

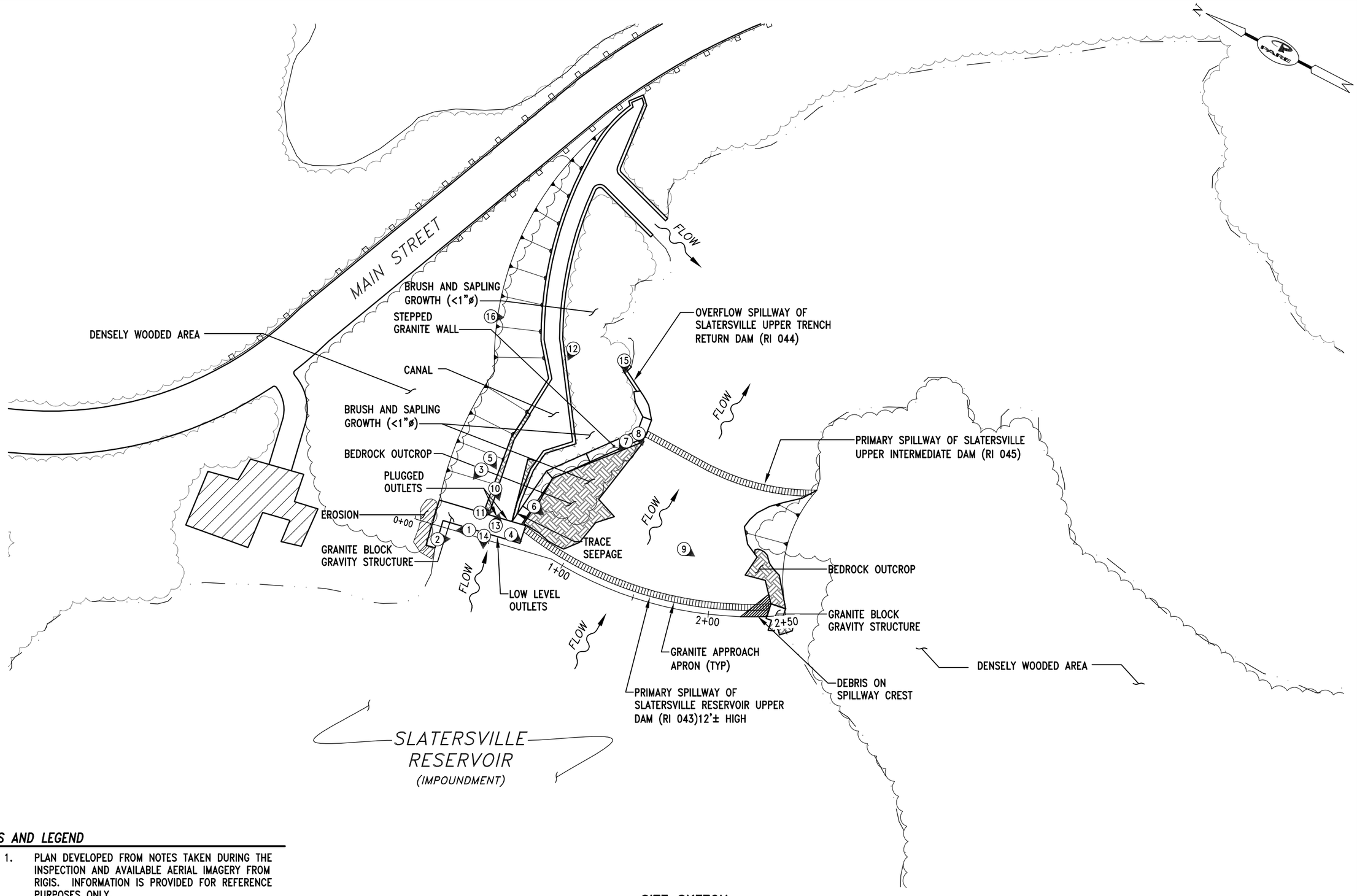
Photo No. 12: Low-level outlet canal from the downstream area.

Photo No. 13: Low-Level outlet discharge canal and left canal slope. Note bedrock outcrop and stumps along the slope..

Photo No. 14: Impoundment as viewed from the dam crest above the low-level outlet intake.

Photo No. 15: Primary spillway discharge channel from the downstream area looking upstream. The arrow indicates the downstream toe dam (Slatersville Upper Intermediate Dam RI#045).

Photo No. 16: Downstream tailwater pond beyond Dam #045. Water in the foreground is the low-level outlet canal.



SITE SKETCH
SCALE: 1"=60'

NOTES AND LEGEND

1. PLAN DEVELOPED FROM NOTES TAKEN DURING THE INSPECTION AND AVAILABLE AERIAL IMAGERY FROM RIGIS. INFORMATION IS PROVIDED FOR REFERENCE PURPOSES ONLY.

(#) DENOTES APPROXIMATE LOCATION AND DIRECTION OF PHOTOGRAPH.

1+00 BASELINE AND STATIONING

PARE
PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 103
FOXBORO, MA 02035
508-543-1755

SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

SLATERSVILLE RESERVOIR UPPER DAM
RI DAM #043
NORTH SMITHFIELD, RHODE ISLAND
DUDLEY DEVELOPMENT CORP.

REVISIONS:	

PROJECT NO.:	16178.03/001
DATE:	MAY 2019
SCALE:	AS NOTED
DESIGNED BY:	DRC
CHECKED BY:	JMB
DRAWN BY:	DRC
APPROVED BY:	JMB

SITE SKETCH

FIGURE NO.:
1